Regional HOT Lanes Network Feasibility Study

Task 4 – Policy and Operation Considerations for a Regionwide Bay Area HOT Lane Network

Prepared for:

Metropolitan Transportation Commission

and

California Department of Transportation

Prepared by:

PB Americas, Inc.

with

ECONorthwest

December 2006

TABLE OF CONTENTS

1.1 INTRODUCTION

The Metropolitan Transportation Commission (MTC) is examining the potential of expanding the existing and planned high-occupancy vehicle (HOV) system by creating a regional network of high-occupancy toll (HOT) lanes. This could be done by converting existing HOV lanes to HOT lanes and expanding the HOV and HOT systems where possible. Potential benefits include more efficient use of freeway capacity and a more reliable and faster travel option for carpoolers, vanpoolers, express bus riders, and toll payers. HOT lane revenues would be used to fund operation of the HOT lanes and may, in some cases, help fund express bus operations or expedite capital improvements including expansion of the HOV/HOT network.

This study recognizes previous work performed by the Alameda County Congestion Management Agency (ACCMA) and the Santa Clara Valley Transportation Authority (VTA) on HOT lane planning as well as work of the California Department of Transportation (Caltrans) on HOV lane planning. Specifically, planning associated with I-680 over the Sunol Grade and I-580 by ACCMA and the system review in Santa Clara County by VTA is considered.

In examining the potential for a regionwide network of HOT lanes, it is critical to consider the public policies guiding development and operation of these existing and future lanes. This is especially true in the San Francisco Bay Area where there are state, regional, county-level, and local government agencies with interests and possible roles in tolling. From the traveler's point of view, consistency of tolling approaches can be important. From the view of partner public organizations, clarity about operations practices, use of tolls, application of tolling technologies, and enforcement will be important to coordinate. This report reviews the following key topics and describes how each is addressed in this study.

- HOT Lane Design Principles and Physical Access
- Interface With HOV Lanes
- Pricing Policy, Tolling Infrastructure, and Technology
- Linkages to Regional ITS Architecture
- Maintenance
- Enforcement
- Public Acceptance
- Equity
- HOV Facilities and Planning Efforts in Neighboring Regions
- Governance

Some topics are important to address at this stage because they will affect potential users' views of the value and cost of HOT lanes. Those topics are reviewed and preliminary recommendations are made for each. Examples of these include the form of pricing (i.e., dynamic) and the general approach to lane design (i.e. striping with a buffer). These approaches can be reviewed and refined but it is essential to treat them consistently within the framework of a regional network.

Other topics, while important to tolling, have less influence on how travelers will respond to the availability and pricing of a HOT lane. Governance is such an issue. While critical to determining stakeholder acceptance and how tolling will be implemented, it does not have an immediate bearing on the numbers of people who would use HOT lanes and what revenue could be generated. Issues such as governance will be addressed in greater detail at a later stage.

1.2 HOT LANE DESIGN PRINCIPLES AND PHYSICAL ACCESS

A driver's access to and use of a HOT lane influences the safety, performance, costs, and enforcement of HOT lanes. Key issues are the type of HOT lane operation (part-time or 24/7 as discussed in section 1.3.1 below), type of separation that exists between the HOT and adjacent lanes, and type of access strategy employed. A wide variety of options can be considered, but only a few have been implemented to date. Choosing a particular access and lane separation strategy has wide-ranging and significant safety, financial and operational implications.

How should HOT lanes be separated from adjacent travel lanes?

Recent and ongoing safety studies of HOV lanes suggest that some form of separation between the HOV lane and adjacent general purpose traffic streams may be needed to reduce the probability of crashes and erratic weaving between the HOV/HOT and inside freeway lane. As a minimum, a wider-than-standard pavement marking is now a recent mandatory condition found in the Manual on Uniform Traffic Control Devices for any concurrent HOV lane operating alongside freeway lanes.

What type of access should be considered based on operation policy – limited access or continuous access?

Early HOT lanes (in the mid-1990s) were implemented on barrier-separated HOV lanes because a single tolling location could record all entering and exiting vehicles, thus reducing costs and simplifying enforcement. More recent HOT lanes implemented in Houston, Minneapolis, Denver and soon-to-open in the Puget Sound areas have multiple access points, but prohibit access between these locations. Between access locations barriers, buffers with traffic channelizers, or painted buffers provide lane separation (see photos on the following page).

Restricting access to the HOT lane to designated entry and exit points would be an appropriate strategy based on current practice; however, if HOT lanes were to operate on a part-time basis, it could confuse motorists and adversely impact performance during periods when the lanes were open for general, un-tolled use. Continuous access through open weaving may be another option that is appropriate to consider. At present no HOT lane operates with continuous access because of the inability to track and monitor violators. Placement of tolling stations at frequent intervals to discourage violations is cost prohibitive, both from a capital and fee per transaction basis. The basis for how such tolling technology occurs in the future may make it easier to apply pricing with the use of Global Positioning Satellite (GPS) based on-board equipment which is monitored by side mounted monitors along the HOT lane. This represents a significant leap in technology and adopted practice and is not a concept that will likely be cost effective for 10 to 15 years.

Operational and safety trade-offs exist for limiting access, particularly in the Bay Area environment where continuous access has been accepted for many years. Additionally, the frequency of access openings influences the forecast volumes to be accommodated, number of tolling installations that are envisioned, nature of demand (i.e., long versus short distance trips within a corridor) and, ultimately, the capital, operation, and maintenance costs of a HOV lane system. Closer spacing of HOT lane access points means higher capital and operating costs; longer spacing may result in greater HOT lane demand and revenue. Thus, there is a trade-off to be considered when determining the number of access locations.

How to handle merging HOT lane traffic with regular lanes?

The primary form of access between the HOT and adjacent general purpose lanes are at-grade slip ramps. These ramps are designated breaks in the pavement markings and other soft barrier treatment, such as traffic channelizers, that provide reasonably safe places to enter and exit. Each at-grade slip ramp may contain a weave lane that allows traffic to more safely merge from the general purpose lane

into the HOT lane or vice versa. Direct access ramps would be provided for selected high volume movements at major HOT to HOT lane interchanges.

Direct access ramps and weaving lanes can significantly impact right-of-way requirements, and in turn, project cost. In particular, direct access features at interchanges should be included selectively since their costs are quite high and, in many cases, may precipitate the need for full interchange reconfigurations. These related costs could represent a capital investment greater than the system investment in Bay Area HOV lanes made to date. These physical and environmental costs must be balanced with the operational and safety benefits of various access alternatives.

Barrier-separated lane access

Buffer-separated-limited access

Buffer-separated-continuous access

Buffer-separated-limited access

Slip ramp access with weave lane

At-grade slip ramp access with channelizers

Need for Federal Review

This study recognizes that conversion of HOV lanes to HOT lanes represents a "significant" change to operation of HOV lanes constructed with federal funding and thus will require review by the Federal Highway Administration (FHWA). In its guidance titled "Federal-Aid Highway Program Guidance on High Occupancy Vehicle (HOV) Lanes," FHWA describes the purposes and content of review that will be needed. An excerpt from that guidance is included below:

> A significant operational change may involve any action that has the potential to adversely affect the area's flow of traffic, roadway and traveler safety, and the environment. A proposal to significantly adjust the hours of operation, or to convert an HOV lane to a general purpose travel lane, is considered a significant operational change. Changes which are considered inconsistent with the original project design concept or scope would also require a Federal review as described in this guidance. Examples of significant operational changes could include: -- implementing a pricing option (e.g., HOT lane, toll lane) that would result in single occupant vehicles using an existing HOV lane; …[1]

FHWA has announced that this guidance is expected to be updated within the next several months.

[1] Federal Highway Administration, "Federal-Aid Highway Program Guidance on High Occupancy Vehicle (HOV) Lanes," available: http://www.fhwa.dot.gov/operations/hovguide01.htm.

Assumptions for This Study

This study assumes HOT lanes would be separated by painted double yellow lines as called for in the design of the HOT lane on I-680 over the Sunol Grade and similar to that used on I-394 in Minneapolis. For the network analysis, cost estimates reflect a limited access design. For technical reasons, demand forecasts reflect continuous access. This may affect forecasts of both free vehicles (carpools) and toll-paying vehicles using the HOT lane overall but should not greatly impact the relative demand among corridors.

1.3 INTERFACE WITH HOV LANES

Pricing offers the opportunity to reassess current HOV lane rules and regulations regarding how the lanes operate and who is eligible to use them. This reassessment is desirable because a wide range of factors – safety, enforceability, available capacity to price, and revenue – are influenced by the regional or corridor operation policies in effect.

HOT Lane Service Levels (24-hour or limited-hour operations)

What is the envisioned HOT lane operation policy: part-time or 24/7?

The Bay Area HOV network currently operates under a part-time policy. The lanes are restricted to carpools and other qualifying vehicles during weekday commute periods; at other times, the lanes are open to all traffic. Part-time operation works because congestion is less consistent outside peak periods and extremely low overnight. Full-time operation (24 hours a day, 7 days a week) is used in other areas such as Southern California, where demand is high outside traditional peak periods.

It will become increasingly complicated to maintain part-time operation of HOV or HOT lanes as the network becomes more connected. At the present time, the hours of operation vary by corridor based on the peak travel pattern in each corridor. The potential for driver confusion will be minimized if the hours can be standardized; by necessity, this will tend toward longer hours of operation, including operation in the reverse peak direction on some freeway segments. Full time operation of HOT lanes could minimize driver confusion.

However, the only attempt to convert peak-period only HOV lanes (I-394 in Minneapolis) to full-time HOT lanes was abandoned after a few weeks of operation in 2005 due to public and media criticism. Currently, the I-394 HOT lanes operate during peak periods only.

Adopting a change in operation periods in HOV lanes has been more successfully implemented in other places by extending the restricted periods over time as congestion and demand warrants. Federal program guidance currently does not consider such changes as “significant” in warranting review and evaluation of the project’s operation policy. (See earlier discussion titled “Need for Federal Review.”)

Assumptions for This Study

To provide for a fuller examination of the potential effectiveness of HOT lanes, revenue estimates are based on full-time operation. A sensitivity analysis was conducted to assess the revenue impacts of operation during congested periods only. However, it is important to note three reasons for assuming 24-hour operation:

- This assumption is consistent with the plans for the I-680 Sunol HOT lane project and with the recent study *Santa Clara County HOT Lane Feasibility Study*;
- Part-time tolling could be confusing to drivers and will become increasingly complicated as the HOV/HOT network becomes more connected; and,
- 24-hour tolling generates some revenue from the off-peak and far off-peak periods with small impacts to travelers in the general purpose lanes. Experience elsewhere shows that some

drivers choose to use tolled lanes even if general purpose lanes have free flow (very low demand) conditions; this suggests drivers themselves see a benefit to full-time operation.

Occupancy Requirements for Free Vehicles: Two Persons vs. Three Persons

A major consideration underlying the implementation of a HOT lane network relates to the number of qualifying carpool vehicles eligible to use HOV lanes and that would be eligible to use the HOT lanes free of charge. Under California law, vehicles eligible to use HOV lanes include: qualifying carpools, transit buses, motorcycles, zero emission vehicles, and certain hybrids. Of these, carpools constitute by far the largest number of eligible vehicles. (Large trucks are not permitted in HOV lanes and would likely not be permitted to use HOT lanes as either free or tolled vehicles.)

Vehicle occupancy requirements significantly impact the effectiveness of HOV and HOT lanes. If the number of qualifying carpools large enough, the lane will slow down and fail to offer fast and reliable trips; this, in turn, reduces incentives to carpool or take the bus. Further, the premise of HOT lanes is the use of tolls to manage the number of vehicles in the lane and keep it free flowing, and this mechanism clearly does not work if the number of free vehicles exceeds the target HOT lane volume. Finally, if carpools fill the lane, there will be little or no room for tolled vehicles and the lane may fail to generate enough revenue even to cover operating and maintenance costs.

Caltrans, the California Highway Patrol and MTC jointly set the vehicle occupancy requirements that define qualifying carpools on each freeway in the Bay Area. In most corridors, vehicles with 2 or more persons currently are considered carpools (or HOVs) and are eligible to use HOV lanes during peak periods; these HOV lanes are said to operate under a 2+ HOV occupancy requirement. Most HOV lanes now in the planning stages are proposed to open with 2+ occupancy requirements. In a small number of Bay Area corridors, 3 or more persons must be in be a vehicle to qualify as a carpool and use the HOV lane during commute periods; these HOV lanes are said to operate under a 3+ HOV occupancy requirement. Corridors with 3+ HOV requirements include: I-80 in Alameda and Contra Costa counties, the I-880 approach to the San Francisco-Oakland Bay Bridge, the Carquinez Bridge, and the Richmond-San Rafael Bridge.

A critical public policy question arises with the likelihood that demand by eligible vehicles in many Bay Area corridors will approach the operational threshold of 1,600 vehicles per hour (vph)[2] by 2030 if not by 2015. In many cases, the most cost-effective approach to provide travel time and reliability benefits to carpools, vanpools, and buses will be to increase the HOV occupancy requirement, In a very few cases, it may be possible to address carpool lane crowding through the addition of a second HOV/HOT lane. This is unlikely to be cost-effective in most corridors that are tightly constrained; however, it may be worth investigating in cases where there may be sufficient right-of-way because two-lane facilities have operational advantages.

Increasing occupancy requirements will significantly decrease the number of vehicles eligible to use HOV lanes and almost certainly result in excess capacity in these lanes. Converting the affected HOV lanes to HOT lanes at that point in time offers opportunities to operate the freeway more efficiently. If the goal were to maximize revenue, the former eligible 2-person HOVs would be charged the full toll rate; if the goal were to maximize person throughput, consideration may be given to reduced tolls for 2-person HOVs.

Trade-Offs

Placing different eligibility rules on one corridor or project can impact other links in the network. If one segment has a more restrictive operation policy, users on either end will be forced out, causing artificial bottlenecks on both the HOT and adjacent general purpose lanes. Transitions, such as auxiliary lanes or

[2] 1,600 vehicles per lane per hour is the operational threshold, the level at which a HOT lane can operate reliably. Higher volumes can be carried in a HOT lane but as volumes increase over the 1600 level, there is greater probability that the lane will not function well on a continuing basis.

direct access ramps, may be needed to address changes in operating rules from one project to the next. Many examples exist where eligibility rules are different by corridor, as in the Bay Area and where more restrictive rules are imposed through tolling or access, as evidenced by SR 91 in Orange County.

Assumptions for This Study

The initial evaluation tests revenue generation on potential HOT lanes under the present or planned vehicle occupancy requirements. In addition, the assessment considers increased vehicle occupancy requirements in corridors where demand is projected to approach the HOV lane operational capacity if current occupancy requirements are maintained.

Potential Impact of Hybrid and other Low or Zero-Emission Vehicles

Under state and federal law, certain hybrid[3], alternative fuel and electric vehicles may use HOV lanes even if they do not meet HOV occupancy requirements. Use of these lanes with only one occupant requires an identification sticker issued by the California Department of Motor Vehicles (DMV).

Hybrids were first permitted to use HOV lanes in California in the fall of 2005 based on 2004 legislation (AB 2628). A bill signed into law by Gov. Arnold Schwarzenegger (AB 2600) in August 2006 grants the DMV the authority to dispense 10,000 additional stickers beyond the 75,000 authorized by the original 2004 legislation and extends the period of the program for the next five years (until January 1, 2011 or until the Director of Transportation determines that federal law does not authorize the state to allow hybrid vehicles use of HOV lanes and notifies the Secretary of State of this determination). AB 2600 takes effect January 1, 2007. At this time, the only hybrid vehicles permitted to apply for the stickers are cars of the following model year and make: 2000 – 2004 Honda Insight, 2003 – 2007 Honda Civic Hybrid, and the 2001 – 2007 Toyota Prius.

If these energy efficient and/or cleaner air vehicles become a significant portion of the vehicle volume in HOV lanes, it could limit the potential effectiveness of tolling.

Based on the recent Caltrans report, *Determination Report: Hybrids on the High Occupancy Vehicle Facilities in California* (June 2006), it was determined that on a statewide level there is no significant HOV lane breakdown directly attributable to the operation of hybrid vehicles on the HOV facilities. The study compared the level of service (LOS) data at locations for which data was available for both 2005 and 2006. A breakdown in conditions is experienced when the LOS declined from LOS "C" or better to LOS "D" or worse. The study found 3 percent to 5 percent of HOV lanes monitored in 2006 have degraded levels of service after April 2005. While the study found it is not possible to attribute degraded conditions directly to the incremental hybrid traffic, several of the Bay Area corridors found to have degraded HOV conditions also show a fair number of hybrids in the HOV lanes.

Assumptions for This Study

The assumption made is that hybrids and low/no emission vehicles will be treated the same as other vehicles in 2015 and 2030. While this is not true today, there is no basis for assuming that such vehicles will become even more prevalent or that state policy will give them either greater or lesser preference. As forecasts are reviewed, the potential effect of giving preference to hybrids and low emission vehicles will be noted.

[3] Note that not all vehicles classified as clean fuels, hybrids, zero emissions, or low emissions are authorized to use HOV lanes. ARB provides a list of such vehicles that are authorized to use HOV lanes on its website at http://www.arb.ca.gov/msprog/carpool/carpool.htm

1.4 PRICING POLICY, TOLLING INFRASTRUCTURE, AND TECHNOLOGY

The successful operation and maintenance of HOT lanes will be dependent on monitoring, toll collection and enforcement technologies that could be evolving rapidly over the coming decades. The associated life-cycle costs of some infrastructure could be very short as convergence in applications and technology continues.

Pricing Policy Options

There are a number of tolling strategies in use today, ranging from fixed price schedules to true "dynamic" pricing where prices vary in real-time according to congestion levels ("not to exceed" limits are sometimes put in place to provide some pricing assurances). San Diego and Minneapolis HOT lanes currently employ dynamic pricing. Most HOT facilities in the future are likely to move toward dynamic pricing as way to maximize revenue and to more efficiently manage congestion, especially as technology measuring congestion levels becomes more sophisticated. The I-680 Sunol facility is being developed to be dynamically priced, and it is our assumption that any regional HOT Network would also be dynamically priced considering operation of both the HOT and adjacent mixed-flow lanes.

How should toll lanes be monitored for dynamic pricing?

There are different ways to monitor freeway use to determine HOT lane dynamic toll rates: 1) monitor HOT lane only; 2) monitor both HOT and general purpose lanes. At issue is how much is invested in capital infrastructure in order to more accurately assess freeway conditions, better manage traffic to assure the HOT lane is not over-utilized, assure time savings for HOT lane users and maximize toll revenues. Existing HOT lane operations monitor HOT lane volumes only. Recent analysis coming out of the I-680 Sunol HOT lane project indicate that the additional revenues gained by a more robust monitoring system extended to the general purpose lanes could far exceed the capital cost of installing that system. More evaluation will be needed to determine the cost-effectiveness of a HOT/general purpose lane monitoring system.

Tolling Systems and Technology Options

Since pricing was first demonstrated on HOV lanes a decade ago, the tolling systems employed have ranged from simple stickers or permits issued for a flat fee on a per-trip or weekly/monthly basis to the use of leased electronic transponders and roadside toll tag readers. Dynamic pricing on HOT lanes with multiple access points calls for a more sophisticated tolling infrastructure than that used on projects with single tolling locations and barrier-separated HOT lanes.

The likely tolling system for dynamically-priced HOT lanes in the Bay Area will involve a fully automated electronic toll collection (ETC) system. These real-time systems include roadside or overhead devices (toll tag readers) that communicate with on-board automatic vehicle identification (AVI) units (also called electronic transponders or toll tags) in passing vehicles. The identification (ID) of the passing vehicle is combined with the current toll rate and other transaction information collected in real-time, then packaged and sent to a central computer to be processed against the registered toll account. If an ID is not obtained, the system records a violation.

Two electronic tolling technologies are currently in use. One is digital short-range communication (DSRC), which is widely adopted in the US and typified in the familiar FasTrak® transponders that go on the windshield and are interrogated by overhead gantries spaced at regular intervals. The other is based on Global Positioning Satellite (GPS) plus some form of wireless communication. The trade-offs between the two involve differences in cost for the on-board unit and for the necessary roadside equipment. In basic terms, the DSRC approach features simple, low-cost on-board units (indeed, as simple as the recently introduced "sticker tags" that cost only a few dollars) but requires a substantial infrastructure investment of gantry-mounted equipment, potentially at every entrance and exit point on the HOT lane

roadway system. By contrast, the GPS approach features an expensive on-board unit, but at least potentially requires far less extensive roadside equipment, since the on-board unit keeps track of where the vehicle gets on and off.

The German GPS-based system, which tracks and tolls heavy truck use, involves the implementation of 5,200 toll reader sites along 24,000 kilometers (14,160 miles) of freeways, representing an average reader spacing of one every 2.7 miles. At present GPS-based systems are better suited to systems with large mileage but relatively limited numbers of vehicles—such as long-distance trucks on a nationwide system like in Germany. The more-costly GPS on-board units are better suited to a professional fleet, and they can carry out a number of functions in addition to toll collection. But for systems involving millions of vehicles, especially urban toll roads, total system costs are much lower for DSRC systems.

These sophisticated electronic toll systems make HOT lanes possible by permitting efficient collection of tolls. Additional equipment is needed to make the system work. Additional roadway infrastructure includes traffic monitoring systems (to collect data used to set tolling levels), electronic and other signage to communicate with motorists, and enforcement support. Toll and enforcement installations on common gantries often go hand-in-hand, with data fed off-line to a processing center for both debiting of payments and handling of toll evasions. HOT lane operations may rely on current intelligent transportation system (ITS) instrumentation in and along the roadway for these purposes, but likely will require additional investment for:

- Closer placement of closed circuit television cameras (CCTV);
- Greater frequency traffic sensors including loops in pavement, side mounted or overhead DSRC readers;
- Greater frequency of variable message signs (VMS) installations to advise lane status and toll rates;
- Cameras mounted at toll readers and additional mobile and fixed field infrastructure to capture and follow-up on toll violations.

Additional on-site or centralized system investment is needed to process toll transactions and violations, set tolls, and convert traffic monitoring data into travel time information provided to motorists.

Where multiple access locations are planned, as in the Bay Area HOT lanes network, the additional investment in roadway equipment may be considerable because more equipment is needed over any given HOT lane distance.

Example of overhead RF antennae used with AV

Example of cameras mounted at tolling installation

Assumptions for This Study

For purposes of preliminary costing of tolling infrastructure, the following pricing and technology assumptions are recommended for this study:

Pricing

- Assume limited access
- Assume dynamic pricing with price set within each segment of HOT lane between access points
- Dynamic pricing can vary by direction and segment (but does not have to)
- Average interval of three to five miles between each segment or between major freeway interchanges if less than three miles.

Technology:

- DSRC readers spaced one per segment, or an average frequency of four miles. (Placing a reader at the entrance and exit of each segment would double the associated cost.)
- A limited number of additional DSRC transponders are included over and above the number currently in circulation for toll bridges.
- Readers located immediately downstream of each entrance on same sign pedestal as a VMS posting the price and travel time in the opposite direction, thus there are two such installations in each direction for access openings in each direction. (If access openings are offset, pedestal and installation costs could double.)
- Only one VMS installation advertising the price and travel time is provided at each access opening.
- Each installation contains two redundant readers and enforcement cameras in each direction.
- Communication along the freeway is not assumed to be shared with any existing fiber telecommunications ITS infrastructure that may already exist. This assumption will be revisited when more corridor detail is developed.

Cost Basis

- Current year unit prices are applied.
- Variances from above are covered with a contingency.

1.5 LINKAGES TO THE REGIONAL INTELLIGENT TRANSPORTATION SYSTEM (ITS) ARCHITECTURE

A regional HOT lanes network could potentially have linkages to several elements of the regional intelligent transportation system (ITS) architecture. Linkages with the FasTrak® electronic toll collection system in place on Bay Area toll bridges are probably the most readily apparent. Other appropriate linkages could include those to: the regional traveler information system, freeway traffic management center, and incident response system.

For this assessment, it is assumed that the electronic tolling system on Bay Area HOT lanes would use the FasTrak® technologies in place at the time of implementation. The Bay Area Toll Authority (BATA), which currently handles customer billing and account management functions for FasTrak®, would handle these same functions for HOT lane transactions. AB 2032 states that toll collection for HOT lanes should operate entirely by electronic means. It also requires the use of equipment that is interoperable with ETC systems currently operating in California. FasTrak® transponders are currently used on all toll facilities in

northern California, and the HOT lanes demonstration projects under development in Santa Clara County[4] and Alameda County are expected to use the FasTrak® electronic toll collection system.

Protocols similar to those used for BATA would be used for the HOT lane tolling. The standard on the west coast for interoperable ETC equipment is Title 21 transponders. HOT lane toll collection on corridors in the Bay Area is assumed to continue to rely on transponders that are compatible with the region's bridges. In order for ETC to be successful for use on HOT lanes in the Bay Area, toll collection would need to fit the BATA structure.

The regional HOT lanes network might also have linkages to the region's traveler information system, traffic management center and incident response system. The current thinking is that HOT lanes demonstration projects should develop traffic monitoring and traveler information systems (changeable message signs) that are independent of (and possibly redundant with) comparable systems for the freeway in general because proper maintenance and operation of these systems is so critical to effective tolling operations. When it comes to a regional network, it may or may not make sense to create systems for the HOT lanes that are independent of those for the freeway in general; however, at a minimum, there are opportunities to share data. Traffic monitoring data from the HOT lanes (e.g., speeds and travel times) as well as tolling levels could be transmitted to the region's traveler information system to help travelers plan their trips. Likewise, traffic monitoring data could be transmitted to the region's traffic management center and incident management systems for day-to-day operations and incident detection and response.

It is worth noting that the pilot projects under development in Alameda and Santa Clara counties will likely develop independent toll setting and toll collection systems that will feed into the FasTrak® account management functions performed by BATA. It is very likely that the two counties also will develop independent traffic monitoring and traveler information systems for reasons mentioned above. One challenge in developing a regional network could involve integrating these pre-existing systems.

1.6 MAINTENANCE

Maintenance concerns can be divided into to broad areas: roadway maintenance and maintenance of tolling and enforcement systems, many of which involve ITS applications.

Roadway maintenance generally includes the same basic functions currently performed by Caltrans. However, there may be some additional maintenance requirements for roadway infrastructure specific to HOT lanes, including fixed signs and associated structures, markings and traffic separation treatments. Operations and maintenance costs include equipment maintenance but not pavement maintenance.

Tolling and enforcement systems represent the largest maintenance cost for a HOT lane system. Further, maintenance of these systems is crucial to maintaining system reliability to protecting the integrity of the program. There are several considerations discussed below.

Maintenance of Field Infrastructure

In order to ensure high system level reliability, a comprehensive maintenance program, including preventive maintenance, diagnostic maintenance, and repair, is required for all toll system field elements/infrastructure. This includes, but is not limited to:

- Radio Frequency Identification (RFID) (or other ETC device) system elements (readers, antenna, transceivers). RFID is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.
- Changeable/variable message signs and variable message signs (CMSs/VMSs)

[4] TY Lin International and Wilbur Smith Associates, *Santa Clara County HOT Lane Feasibility Study*, December 2005, available: http://www.vta.org/projects/hot_lanes/hot_final.pdf.

- CCTV surveillance cameras
- Video-camera detection systems for Violation Enforcement System (VES) (cameras, arms, etc.)
- Communications infrastructure (wireless modems, antenna, and fiber/hardwired communications cabling)
- Electrical infrastructure (wires, cables, connectors, pull/junction boxes, etc.)
- Vehicle sensor equipment (loops, side-firing radar detectors, treadles, etc.)

The toll system application should incorporate a maintenance on-line management system (MOMS) which: helps identify and track preventative maintenance plans and actual maintenance conducted; allows for notes to be recorded about various field elements; permits equipment to be accurately managed, including a spare parts inventory; and automatically monitors and generates timely notification alarms to maintenance staff who are responsible for testing, maintaining, and responding to ad-hoc system interruptions or device failures. The MOMS should be capable of automatically paging a maintenance technician remotely, and it is the technician's responsibility to assess, troubleshoot, and repair system failures identified by the MOMS.

Routine maintenance reporting will be an important aspect of the toll system reporting feature, and the system should be capable of producing a total system uptime report that calculates a percentage failure rate for all parts, and for the system at large.

Software Maintenance

Software maintenance is important to the long-term success of HOT lanes. Service provider staff and system operators will need to be trained how to use and update the integrated ETC software system. However, the trend in software is to outsource the software's maintenance to a vendor (the company that provided the software or a third-party vendor). It is unlikely that agency or service provider staff who currently has expertise will understand all of the areas required to make the system work well. Additionally, the software should not require a full time employee for maintenance. While not recommended, it is also possible to outsource all of the software management and maintenance functions. The designated service provider should carefully weigh the short and long-term benefits and risks of outsourcing software management.

Network Maintenance

While the end devices are different from those in a typical local area network (LAN) or wide area network (WAN), the concept of LAN/WAN applies to the HOT lanes Electronic Toll and Traffic Management (ETTM) system. Just as a LAN or WAN needs network support, so will the HOT lane ETTM network. Both the network and end devices will need to be monitored for proper operation and replacement when they are not functioning properly.

Important considerations for the HOT lanes information technology network include appropriate systems support for data archival, redundant power and communications, proper hardware and software for data storage and processing, proper environmental conditions for server placement and appropriate security for safeguarding of the central computers. Adequate assurances of the stability of the managed lanes network are thus an important area of emphasis. The administration of the network will require some level of dedicated staffing.

System Auditors

A plan of regular, independent periodic tests of the hardware, software, and network systems should be planned that test the HOT lanes and host systems continuity, accuracy, adherence to procedure, and to vouch for the integrity of the transaction postings. The system audit should be easily reconciled to the financial system transactional audits. If travelers feel that their ETC account is being mismanaged, they are unlikely to consider using the HOT lanes.

Agency Roles

The operator, or service provider, of a HOT lane could be an agency, private firm, or a consortium that operates and maintains the HOT lane infrastructure. The maintenance of the HOT lane should be provided by the owner (Caltrans), service provider, developer or some joint arrangement among them. The shared HOT and general roadway maintenance suggests that Caltrans is the appropriate agency to perform this function as the facility owner. Some additional roadway responsibilities may be included for fixed signing and, perhaps, other traffic control devices such as channelizers if they are applied. A wide variety of other agency and public/private business models are possible for providing the ITS, toll and enforcement devices and infrastructure supporting HOT lanes. The maintenance responsibilities for these systems are best included with the service provider of this equipment.

Annual Operating and Maintenance Costs

Operating costs likely to be incurred on the HOT lane system are divided into three categories: operations, maintenance as described above and violation processing. Each category includes functional areas for the provision of services associated with the tolling operation.

Operation costs involve administration, finance and accounting, customer service, and support staff at the tolling center. Operating expenses can include facility costs, office equipment costs, supplies and other direct costs associated with account management and revenue handling. In an established operation, the operating costs/expenses can be estimated to increase somewhere between $200,000 and $500,000 for every additional one million transactions processed. Thus, the greater the number of toll reader sites, the greater the cost associated with these transactions.

Maintenance costs involve preventative and corrective maintenance activities (as described above in this section) of the roadside tolling equipment and collection locations and central computer systems and application software. Maintenance expenses include facility and vehicle costs, technical support type contracts, and consumables. Depending on the scale of the deployment, maintenance services will generally cost $100,000 to $500,000 annually per corridor (assuming a typical project that might be from 10 to 30 miles in length assuming from four to six reader sites). Some economies of scale are possible for a systemwide application.

Violation processing costs involve violations image review, finance and accounting, customer service, and appeals and hearing support. Additionally the cost of on-site enforcement activities and judicial or other adjudication proceedings must be included. Violation processing expenses include facility costs, office equipment, lookup fees, supplies and other direct costs associated with revenues handling. Excluding fixed costs for facilities and computer assets, the operating expenses can be estimated to be between $100,000 and $500,000 annually for every 100,000 violations processed.

Operating costs can be significantly reduced if the operations activities are supported by web-based applications. On-line account management and payment, including for violation fines and fees, on-line account statements, and other e-services dramatically reduce the cost of service center operations, even if combined with current toll facilities in the Bay Area.

Operations and maintenance costs were estimated to be $70,000 per lane mile per year. This is consistent with the approach being used by ACCMA for the I-680 Sunol HOT Lane project.

1.7 ENFORCEMENT

Successful operation of an HOT lane system depends on a high level of compliance of the traveling public with the regulations that govern the use of the lanes. Effective enforcement is critical to HOT lane operations for several reasons:

- HOT lanes can be managed only if the number of users is regulated at below the operational threshold of the lane. With inefficient or non-existent toll enforcement, ineligible drivers unwilling to pay will cheat and deprive the owner and operator of revenue.

- If cheaters go unpunished, it may embolden travelers who were otherwise willing to pay the toll to cheat, too.
- High violation rates erode public support for dedicated lanes.

Identification of Issues

The three most common offenses associated with HOT lanes include:

- Occupancy violations-- not having the requisite number of persons in a vehicle.
- Toll evasion-- avoiding paying tolls at the prescribed price in effect.
- Access violations-- crossing a buffer where access is restricted.

The importance of each violation is influenced by the facility design and intended operation rules. For example, a HOT lane with a physical barrier will not have any access violations. Technology and institutional issues play a key role in what is considered accepted practice in apprehending and citing occupancy violators. Current practice for addressing each in HOV and HOT lanes is summarized below.

Occupancy violations

Issue	Manner addressed
Seeing inside a vehicle	Passage and enforcement of tinted window legislation, and improved corridor illumination.
Separating free from paid lane users	Placement of a monitoring booth in the median or installation of toll tag readers in police cars
Monitoring, apprehending and citing	On site enforcement presence, through provision of full breakdown shoulders or dedicated enforcement areas where pavement is widened. No automated strategy is currently being applied.
Maintaining an acceptable compliance	Saturated, random patrols, often dedicated to this purpose.

Toll Evasion

Issue	Manner addressed
Evading at tolling station	Enforcement handled remotely. Cameras document vehicle license plate and driver, legislation to allow ticket by mail and back-room support to process citations (or bills)
Evading along a buffer separated lane	Consider placing hard or soft barriers along lane, like pylons or traffic channelizers. Place cameras and readers at a frequent enough interval to photograph evaders. Visible enforcement by patrol officer.

Access Violations

Issue	Manner addressed
Entering or exiting at restricted locations where pavement striping precludes access	Apprehend and cite via on-site enforcement presence, as is done on a majority of HOV lanes with access restrictions. Automation is possible but expensive. Another option is to adopt soft barrier treatment in the restricted sections with pylons or traffic channelizers.

Other Concerns

Issue	Manner addressed
Adequacy of signage and fines	Assess fine structure and place fine structure rate sufficient enough to discourage violations, but not so high as to have a large number of citations contested in court. Make sure signing adequacy meets police and traffic court acceptance.
Lack of dedicated enforcement presence	Fund overtime or dedicated enforcement personnel, post fines to discourage violators
Safety for on-site activities	Dedicated enforcement monitoring and apprehension areas, either through full width median shoulders or strategically placed enforcement areas.

Challenges and Opportunities

Adequate funding for highway patrol presence is a key. Effective HOT lane enforcement requires distinguishing between paid and free users while counting occupants. While median-oriented monitoring booths and dedicated HOV lanes were created to separate HOT traffic at a single location where tolls were collected in other projects, this is not practicable for a non-barriered setting. However, with the advent of new mobile police monitoring equipment now being demonstrated in Minneapolis, this may not be necessary.

Soft or hard barriers will offer potential to limit access, and current or emerging technology may allow for the ability to distinguish quickly and from any vantage point who has paid and who is a free carpool. Perhaps a decade or so from now, GPS-based tolling will permit easy detection of access violations, and there is a possibility that in-vehicle monitoring or occupancy detection will automate this function as well to reduce enforcement presence.

Considerable experience from other locations will provide options for addressing enforcement issues. Cost and effectiveness are appropriate factors to determine whether more frequent reader/camera monitor installations, more patrol officers, mobile police monitoring equipment, physical separation, or some other methods are a better investment. The recent history of technology adoption suggests that, over time, it is likely that the technology costs will decline.

Policy-makers will be faced with many tradeoff decisions regarding enforcement. These will include choices among different types of technology with widely varying costs, how much it is worth to pay for reduced violation rates, how rigorous enforcement might impair convenience for travelers, and privacy and political acceptability considerations.

1.8 PUBLIC ACCEPTANCE

The expansion of HOV lanes to include tolling is inevitably controversial despite the strong possibility that pricing may offer improved mobility to a large number of users. This section presents the underlying reasons for the controversy and then explores methods to enhance public acceptance of HOT lanes.

Key Issues affecting Potential Controversy

Promotion of tolling in general, and on HOV lanes in particular, is a relatively new concept in the U.S. While tolling has been applied since the inception of roads primarily for bridges and tunnels, there is renewed interest at the local, state and federal levels as gas tax revenues continue to fall in respect to the cost to build and maintain roadway infrastructure. As such, the public may greet toll proposals for HOT lanes with indifference or caution.

Equity concerns, both social and geographical, are a primary cause for public scrutiny where tolling is intended as a user fee to enable facility usage. Other reasons for opposition may include: concerns that

road users should not have to pay to drive on public roads (this can be viewed as "double taxation"); skepticism that congestion mitigation would be minimal; belief that the purpose of HOV lanes would be defeated; concern that public transit would be adversely impacted and frustration that there are already too many other taxes and tolls.[5]

Assessing Perceptions

Surveys show that public perception is generally positive where HOT lanes are currently in operation. California led the nation in HOT lane projects more than a decade ago on SR 91 and I-15 in Orange and San Diego counties. The private consortium that implemented SR 91 found there was general support for tolling, and once open, a wide array of users representing all socio-economic groups used the express lanes, at least for discretionary trips when time and reliability were important. Surveys regarding San Diego's I-15 HOT lanes showed that users and non-users consider the lanes to be fair. DeCorla-Souza, et al (2003) note that survey respondents favor extending the HOT lanes as their top choice for further reducing congestion in the region.[6] A survey published in May 2006 of 550 regular users of the I-394 HOT lanes in Minneapolis showed a 95 percent approval rating of the program regulating use of the expressway. The concept even received a 59 percent approval rating among non-users, with little variation associated with income, education or gender differences.[7]

Findings of market research conducted prior to opening of HOT lanes, when respondents presumably have no direct experience with HOT lanes have been mixed, though many are positive. In a survey conducted in 2003 by the Alameda County Congestion Management Agency, 67 percent of those surveyed supported a HOT Lane on I-680 and just 23 percent strongly opposed the concept.[8] A survey of Lee County, Florida residents in 2002 indicated favorable opinions of proposed HOT "Queue Jumps" (59 percent) and other value pricing alternatives. Likewise, a 2001 survey of Puget Sound Region residents in Washington State revealed strong support of proposed HOT lanes (with 41 percent supporting and 26 percent willing to use the lanes up to three times per week). The Seattle survey is also notable because no statistically significant difference was found between income and willingness to pay tolls.[9] A recent survey of residents in Greensboro, North Carolina, suggests that residents in medium sized cities may also be willing to pay a toll for express service via HOT lanes. An even mixture of community leaders for, neutral to, and against the concept was evident based on survey responses.[10]

In contrast, a survey of South Florida residents in 2000 found little public support for converting of HOV lanes on I-95 to HOT lanes. Over 50 percent of the respondents gave the proposal the lowest possible rating on a scale of 1 to 10. No specific demographic or user groups were identified in support or

---

[5] Cleland, F. and P. L. Winters. *Final Report. Value Pricing: HOT Lanes in South Florida.* October 2000. http://www.cutr.usf.edu/tdm/pdf/HOT%20Lanes.pdf. Accessed July 21, 2006.

[6] DeCorla-Souza, P., A. Jacobs, S. Ballard, and T. Smith. "Paying the Value Price." Public Roads. September/October 2003 · Vol. 67 · No. 2. http://www.tfhrc.gov/pubrds/03sep/09.htm. Accessed July 21, 2006.

[7] Metropolitan Council. "I-394 Toll Lane has Public Support." http://www.metrocouncil.org/directions/transit/transit2006/mnpass.htm. Accessed August 7, 2006.

[8] Alameda County Congestion Management Agency. Polling conducted by Evans McDonough. August 10 through 17, 2003.

[9] Federal Highway Administration (FHWA). "Chapter 4: Achieving Public Acceptance." A Guide for HOT Lane Development. FHWA-OP-03-009. 2003. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13668_files/chapter_4.htm Accessed July 21, 2006

[10] Benjamin, J. M., et al. "Analysis of Value Pricing in a Medium-Sized City." Transportation Research Board 85th Annual Meeting CD-ROM. 2006.

opposition. Further, potential strategies for communicating how funding might be used had little effect on those who opposed the general concept.[11]

Strategies to Address Public Acceptance

Strategic public relations may offer opportunities to enhance public acceptance when market research suggests negative or polarized public attitudes exist toward a proposed HOT lanes project. By identifying the key issues of concern, the appropriate method(s) may be selected from the following potential menu of options:

1. Marketing Message: A benefit to all on an "as-needed basis"; Travelers "have the option"

Marketing HOT lanes as a benefit available to all users on an "as-needed basis," rather than a concept that creates two classes of users, can help to address equity issues. Minnesota DOT planners have identified this approach as the key to making HOT lanes work.[12] On existing HOT facilities in California (SR-91 in Orange County and I-15 in San Diego) people of all income levels use and benefit from HOT lanes when saving time is important to them.[13] In addition to creating an equitable image with this marketing message, combining pricing with direct benefits to low-income users, such as "life line" toll credits, may also be effective in addressing equity concerns.[14]

2. Marketing Message: Opportunities to Avoid the Toll

In determining the feasibility of converting the North I-25 HOV facility in Denver, Colorado, to HOT lanes, the Colorado Department of Transportation (CDOT) conducted focus groups with commuters and business owners, stakeholder outreach, public open houses, and a stated preference telephone survey. This market research and public outreach effort concluded that:

- Support for HOT lanes is growing;
- Issues of income and equity are less pronounced than anticipated;
- Opportunities to avoid the toll by carpooling or riding the bus can favorably affect public opinion; and
- A regional multimodal transportation system is desired as a long-term solution, with HOT lanes as an interim option.

The CDOT concluded, "co-marketing the HOT lane option with a means of avoiding a toll (through carpooling or riding the bus) may favorably affect public acceptance."[15]

3. Marketing Message: Enhanced reliability and speed benefits all users

Prior to the implementation of HOT lanes on the Katy Freeway (I-10) in Houston, Texas, this message was delivered via focus groups, new releases, interviews with agency staff, and media coverage. HOT

[11] Cleland (2000).

[12] DeCorla-Souza (2003).

[13] Parry, I. and E. Safirova. "Turning up the Heat on Traffic Gridlock." Resources for the Future. 2004. http://www.rff.org/rff/News/Features/Turning-up-the-Heat-on-Traffic-Gridlock.cfm. Accessed July 21, 2006.

[14] DeCorla-Souza (2003).

[15] Ungemah, D., M. Swisher, C. D. Tighe. "Discussing High-Occupancy Toll Lanes with the Denver, Colorado, Public." *Transportation Research Record: Journal of the Transportation Research Board*, Issue Number 1932, 2005, pp. 129-136.

lanes on the Tappan Zee Bridge in New York (for commercial vehicles) were similarly touted for the benefits of reduced peak period travel, as well as improved air quality.[16]

4. System Context: The value of the HOT lanes approach

"Market research indicates that public acceptance increases when HOT lanes are presented in the context of a system that offers users more choices, showing the other alternatives for reducing congestion that have been implemented or examined, along with their associated costs and benefits."[17] Similarly, transportation officials with the Colorado Value Express Lanes project are using "Pricing works well in other places" as their primary marketing message. Many agencies have found that providing specific examples of congestion pricing and benefits are helpful when presenting the value of a HOT lanes approach.[18]

5. Financial Context: HOT lanes versus tax increases and designated revenue uses

Executive stakeholder interviews and focus group studies in Atlanta, San Diego and Denver all found that HOT lane revenue is important, and a clear link needs to be drawn between the basis for why a toll is collected and where the excess revenue will go. In every project or study to date, the sentiment has been that excess revenues should be reinvested in a corridor or geography that is impacted and that, to the extent possible, revenues go to address other transportation needs and equity-related issues. In the case of San Diego, for both the I-15 and I-5 corridors, excess revenues have or will support additional bus services and related transit and transportation improvements.

A January 2002 survey in Minneapolis-St. Paul, Minnesota, showed that the HOT lane concept might gain public support when suggested as a transportation revenue source. Survey respondents indicated they would favor HOT lanes (57 percent support level) over a gas tax (53 percent) or sales tax (52 percent) increase.[19]

6. Marketing Messenger: The Political Champion

All of the strategies proposed above require the dedication of one or more political champions. More importantly, the lack of a champion or presence of one or more opponents have been reasons why so few technical studies of HOT lanes since 1995 have resulted in projects that have moved forward, since most were found to be technically feasible. More than 25 studies were completed in the period from 1995 to 2005, yet during this period only four HOT lane projects in California, Minnesota and Houston were implemented. Having a political champion, coupled local and state agencies willing to collaboratively move forward, are important factors in being able to demonstrate and implement pricing as a traffic management tool.

1.9 EQUITY

Debates about equity have been part of proposals for high-occupancy toll (HOT) lanes since the inception as a serious proposal to manage and fund road systems. They are of particular concern to some elected officials and interest groups who perceive HOT lanes to be an inequitable way to solve transportation problems by disproportionately benefiting one group or another. Equity is a highly subjective concept with

[16] Collier, T. and G. D. Goodin. "Marketing the Managed Lanes Concept." http://managed-lanes.tamu.edu/products/reports/4160-7.pdf. April 2002. Accessed July 21, 2006.

[17] Lari, A. Z. and K.R. Buckeye. "High-Occupancy Toll Lane System: A Concept Plan for the Twin Cities." Transportation Research Record No. 1659, 1999, pp. 111-118.

[18] Collier and Goodin (2002).

[19] FHWA (2003).

many dimensions. As in all public policy, decision-makers must make trade-offs among different choices and must ask themselves and the public if a particular policy – in this case a user paying a fee to gain the benefit of a faster, more reliable trip – is "fair," as compared to other ways of managing traffic, selecting investment strategies, and financing a facility or a service.

Although most (if not all) infrastructure-related choices raise questions of geographic, functional, social, or other types of equity, pricing when applied by the public sector raises equity concerns. The concept of "market rates" is not commonly applied in public sector infrastructure choices. The perception of public sector management as a non-competitive or public service function places it in a version of a monopoly. There are not parallel highways with different management pricing and operations practices from which to choose. In this situation, it is particularly important to consider both how different types of users will be treated and what has been learned from other similar experiences.

What constitutes equity in this program (income, geography, modal, etc.)?

1. Income. HOT lanes have been dubbed "Lexus Lanes" by some critics, referring to the notion that an affluent person (the presumed Lexus owner) is better able to afford the toll than is a person of low-income and is therefore selectively benefited. Some HOT lane critics have also asserted that disparities of income associated with ethnicity or gender add another element of inequity.

However, data on existing HOT lanes has shown that low-income drivers do use them and are as likely to approve of the lanes as drivers with higher incomes. Research has also found that most users, regardless of income, do not use the HOT lanes on a daily basis, but only do so on occasions when their cost of delay is greatest and their time has the highest value. This situation can apply to anyone regardless of income level. For example, some people lack flexibility in job arrival time or childcare pickup time, or are working two jobs. People in these situations might find the HOT lane an attractive option to reduce the risk of arriving late at their destination. Essentially, this points to the value of reliability provided by HOT lanes.

HOT lanes in the Bay Area would be converted HOV lanes or newly constructed lanes. Thus, HOT lanes would provide an additional option for drivers, but would not require that anyone pay a toll. Only drivers who decide that saving time or gaining reliability of trip time is worth the toll on any given occasion will choose to avail themselves of HOT lane benefits.

If income equity is still deemed to be a serious concern, it might be alleviated by using toll revenue to promote development of carpools and vanpools or enhancing or expanding regional express bus service. These services allow people to benefit from the HOT lanes even if they lack access to an automobile or cannot afford to pay the toll. A second option to alleviate concerns about income equity is to provide a program of toll discounts for certified, eligible low-income individuals. The number of travelers who could qualify for discounts may differ by corridor and could make this a complex undertaking at the regional level. A recent study of the I-580 and I-680 corridors suggested the number of low-income users in these corridors would be small and, thus, offering discounts would not significant impact HOT lane operations.[20] However, it is possible that in some corridors the number of low-income users could be large enough that a low-income discount program would reduce the operational effectiveness of the HOT lane.

2. Geography. Because HOT lanes would typically have limited access points, the locations of access points could affect equity by determining who does and does not have relatively easy access to the lanes. Both HOV lanes and potential HOT lanes by their nature attract relatively long-distance trips, especially commute trips. For a HOT lane from a distant suburban residential community to an employment center, who benefits most -- the residents, the employers, or both equally? What about the communities in between, especially if there are few or no intermediate access locations for them? This latter issue could become particularly prominent when selecting intermediate access locations. The number of access

[20] Alameda County Congestion Management Agency. "HOT Credit Lanes Feasibility Study". August 2005.

points and the efficient operation of the facility would have to be balanced in order for the HOT lane user to experience a benefit from the facility.

3. Modal. Some advocates of HOV lanes raise the issue of modal equity. They fear that allowing otherwise non-eligible vehicles, usually single-occupant vehicles (SOVs), to buy their way into the benefits of the HOV lane could result in congesting the lane and reducing the benefit to HOVs. In addition, there is some concern that the existence of a HOT option would cause some people to shift from HOVs into SOVs. Actual experience with HOT lanes, however, does not bear out these concerns. There has been no noticeable reduction in ridesharing – in fact, the San Diego I-10 HOT lane has shown an increase in carpooling in the corridor since the opening of the HOT lane. Performance of the HOV/HOT lanes remains high in all existing HOT lane projects. Nevertheless, maintaining an acceptable level of service on HOT lanes is extremely critical. It depends upon careful and frequent variability of pricing to regulate HOT lane demand based on actual traffic conditions. That is why "dynamic pricing," which adjusts the toll up or down to encourage or discourage toll-payers on a real-time basis, is the method being used in San Diego and Minneapolis HOT lanes and is expected for a Bay Area system. If done properly, traffic volumes of toll-payers can be regulated to guarantee good performance for both HOVs and paying customers.

Another concern is that the eligibility requirement for free passage on an HOV lane might be increased from 2 persons to 3 persons solely for the purpose of creating more capacity to sell on a HOT lane. While this is possible, the much more likely case is that the growth in demand by 2-person HOVs on a given corridor would at some point compel policy-makers to change to a 3-person requirement because the large number of 2-person vehicles would make the HOV lane so congested that it would no longer offer travel time savings or reliability to buses, vanpools and carpools. In that case, the HOV lane would quickly change from being over utilized to being underutilized. It would then become attractive to convert the HOV lane to a HOT lane in order to make the most efficient use of capacity on the freeway.

How do tolls equitably compare to raising fuel or sales taxes?

Some critics express the view that HOT lanes actually represent paying for something again that they have already paid for once: "I've already paid for the road with my gas taxes, so why can't I use the road without paying again?" This is a similar argument often expressed against the concept of HOV lanes, which are paid for primarily through gas taxes that all drivers pay, whether or not they are able to use the HOV lanes.

Gasoline taxes are roughly proportional to auto usage in general, but the gas tax can be consumed at any time of day or any roadway, so there is no necessary relationship between the burden placed on the other drivers on road system (in the form of added congestion and delay) and the amount of tax paid. The gas tax paid varies greatly by the relative fuel efficiency of different vehicles. Other potential sources for transportation funding are even less equitable from the standpoint of "user benefits/user pays": the sales tax is not a road user fee in any sense and is often viewed as relatively regressive, taking a disproportionate share from low-income households; income and property taxes are entirely unrelated to road usage.

How does raising money through tolls relate to the timing of investments made using the tolls?

In the impact fee field, a nexus must be established between (among other things) the timing of raising the funds and the timing of the investment using the funds. It can be expected that stakeholders and interested parties will want to know that revenues raised today will be used in the reasonably foreseeable future.

Assumptions for This Study

While this study does not include a regional equity analysis, the distribution of costs and benefits for HOT lanes in specific corridors is an important issue that will require additional work in future studies. Analysis

of the distribution of costs and benefits is highly dependent on specific assumptions about such as corridor demographics and travel patterns, access point locations, existing and planned transit service levels, and alternative potential funding sources. For this reason, it is most appropriate to conduct equity analysis in future phases of HOT lanes development once relatively detailed HOT lane scenarios can be defined and analyzed in specific corridors.

1.10 HOV AND HOT FACILITIES AND PLANNING EFFORTS IN ADJOINING REGIONS

Regions adjoining the San Francisco Bay Area have various efforts under way concerning high occupancy vehicle lane planning. There are currently no HOV lanes on facilities where the MTC region joins or abuts neighboring regions.

The San Joaquin Council of Governments (SJCOG) offers the clearest example of planning for a possible HOV lane network. SJCOG is in the very early stages of evaluating the possible effectiveness of HOV lanes on freeways in San Joaquin County and is considering possible linkages with HOV planning in adjoining regions, particularly with respect to I-580 in Alameda County. No alternative HOV networks or proposed projects have been developed at the time of this report. SJCOG is coordinating with MTC and ACCMA on study assumptions and tasks.

The Sacramento Area Council of Governments (SACOG) is not proposing to consider HOV or HOT lane connections with the San Francisco Bay Area. While its board has not adopted a policy on the topic, the general direction of the organization to be considered in some detail in the fall of 2006 is to discourage interregional commuting (i.e., to focus instead on jobs/housing balance within the greater Sacramento region).

There is no known planning for HOV or HOT connections to the south (Santa Cruz, Monterey, and San Benito County areas) or north (Mendocino or Lake Counties) of the San Francisco Bay Area.

1.11 GOVERNANCE

The question of who "governs" or controls a regional HOT lane network has many dimensions, especially in a region such as the Bay Area that already has a complex jurisdictional environment. Governing relates to implementation, funding, operation, and enforcement as described below for a HOT lane network.

Facility Owner

As the owner of California's freeway system, Caltrans is also currently the owner of all (or nearly all) of the prospective HOT lane network facilities. However, some HOT improvements (e.g., toll readers, communications, collection, surveillance, administration, etc.) could potentially be owned by another entity under an agreement with Caltrans, as is the case on SR 91 in Orange County. It could be a regional public agency (like the Bay Area Toll Authority), a series of joint powers authorities among local agencies (e.g., the recently formed Sunol I-680 Joint Powers Authority), or one or more private investors subject to oversight of public bodies. Transportation authorities have engaged in planning and design of State freeway facilities as well as HOV and HOT lane with the cooperation of Caltrans. There is a constructive and collaborative history of State-regional-local coordination of improvements for the State highway system, all featuring Caltrans as the owner.

Service provider

The service provider may be the same entity, or different from, the owner. Major responsibilities would include collection of toll revenues, management of toll pricing schedules and strategies, marketing, incident response, maintenance, and enforcement. The service provider may elect to contract out services to public agencies (e.g., enforcement to the Highway Patrol) or private firms (e.g., an advertising firm for marketing or vendor for toll administration). There is also potential for combined public/private

HOT lane initiatives; for example, a public entity pays for the roadway improvements, while the private investors pay for and own the toll collection system in exchange for a concession to collect tolls for a fixed period of time. Specific roles of both public and private entities may be defined on a project-specific basis, so they are not necessarily the same throughout the region. Once a particular arrangement is in place, it may be difficult to supersede and absorb it into a new, regional mechanism. Hence, long-term thinking on this and other governance issues is essential to better envision a preferred approach.

Developer

A specific HOT lane, or network, could be developed by a public agency, group of public agencies, or a private consortium that builds it and could act as service provider. If different from the owner and service provider, the HOT lane developer would need to coordinate with both entities to make sure the design of the HOT lane meets owner requirements and fits with the operational needs of the service provider. Involving a private developer could permit a project to be built much sooner than otherwise possible with public money alone. If a private developer is involved, there are several models that could be employed. The private developer's roles could be described as:

- Build/Own/Operate, in which private entity takes on all responsibility for the entire facility
- Build/Transfer/Operate, in which private entity builds the facility, transfers to public owner, then leases back to operate for a time period
- Partial Ownership/Management, in which private entity owns some aspect of the facility such as toll collection, while contracting to provide management and maintenance

Allocation of Revenues

The question of how revenues are allocated is closely allied with the governance issue because it raises the question of "who decides?" It is likely that authorizing legislation enabling a regional HOT lanes network would specify, at least in part, how revenues are allocated; this has been the case for all the individual HOT lane projects authorized to date in California. Nevertheless, it is also possible that an expanded HOT lane network would lead to more possible choices and potentially more discretion for whomever is given the responsibility to decide. In that case, it is important to have the discussion in advance about how much flexibility a governing body should have in making these decisions.

Based on recent experience and policies being studied in California and elsewhere, options for revenue allocation could include:

- Annual operations and maintenance (O&M) costs for HOT operations in the corridor (this will almost certainly have the first call on revenues under any scenario)
- Repayment of incremental capital costs of developing HOT capacity on existing HOV or HOT lane facilities in the corridor from which the revenue is derived
- Funding transit services in the corridor to enable alternate means of travel
- Funding improvements within the general corridor but outside the freeway right-of-way (e.g., arterial improvements)
- Capital costs of new facilities in the corridor (e.g., extending the HOT lane, park-and-ride lots, additional enforcement areas)
- Building or operation of HOT facilities in other parts of the regional network, including key connections between high demand corridors

If the region or local implementing agencies consider private sector roles, this could have a major influence on how much revenue is available for allocation. The degree of private investment would depend upon ownership status, risk-sharing, financial terms, toll-setting mechanisms, length of agreement (if the concession model is adopted), the value of individual projects and a potential HOT

network, and other factors. In general, the higher the risk and uncertainty, the higher rate of return an investor will expect. To date no HOT lanes have been considered in a concession because few generate enough revenue to do more than cover their operation and maintenance costs. Several other locations including Atlanta and Houston are examining the opportunity for private sector involvement in adding pricing to their HOV lanes and performing O&M functions.

A major question will be whether revenues should be "regionalized" or should remain strictly in the corridor in which they are generated. To date, the projects already implemented or in advanced planning limit the uses to in-corridor purposes as required by state law. However, if a regional network, rather than a series of separate projects, is the ultimate vision and revenues generated in one project are expected to help fund projects elsewhere, new expectations and agreements must be negotiated. These agreements would have to be perceived as fair by elected representatives and the general public in order to gain acceptance.

In the toll financing field, this general topic is framed by terms such as "appropriations risk." This involves whether the entity raising the funds (or having the funds raised in their local geography) believes that funds should stay in the corridor or may be subject to reallocation to uses not intended by the local parties.

Decisions Concerning Travel Capacity in the Corridor

Because HOT lane productivity, pricing and toll revenues are dependent on demand and capacity, anything that affects capacity and demand in a HOT lane corridor may be important to the effectiveness of a HOT lane relative to stated policy objectives. The question of who decides when and what types of improvements to make within a HOT lane corridor is thus related to the question of governance and revenue allocation. If new general purpose lanes are developed to serve trips in a HOT lane corridor, HOT lane productivity in terms of person throughput and revenue generation may be compromised, even while overall system productivity improves. This may be a consideration whether or not there is private investment in the HOT lane. While this scenario is not very likely, MTC and its partners need to consider circumstances that could affect demand for HOT lane usage.

Recommendations for This Study

Options for governance and revenue allocation will need to be considered as work moves forward to develop a regional HOT lane network. Clearly, as currently authorized HOT lane pilot projects move forward, decisions will need to be made on toll collection systems compatibility and consistency, operations practices, revenue generation and management, and a wide range of topics related to governance.

Critical governance issues include, in addition to which organization(s) play leadership roles, three key policy choices needing continued attention as the region moves forward to develop a regional HOT lanes network. These are:

1. HOV effectiveness – The region will need to consider how to keep HOV lanes effective as HOV volumes increase. As an HOV lane approaches service worse than level of service C (approaching breakdown conditions), it will be important to consider increasing the vehicle occupancy requirement, adding a second HOV lane, or taking some other approach to maintaining the effectiveness of the HOV lane. The assumption is that the HOV function of the lane is primary and the tolling function is secondary. However, for the tolling function to be effective, a lane must also operate reliably for HOVs. A public policy of increasing the HOV requirement when a lane fills to capacity with HOVs is essential to the ability of the region to make HOT lanes successful.

2. Dynamic pricing – In order to manage the number of tolled vehicles allowed into a HOT lane, dynamic pricing is important. As a lane fills, toll prices need to increase to limit the number of

tolled vehicles entering a lane. If this does not occur, the lane can add tolled vehicles to the HOV vehicles and lead to congestion. This suggests that although low tolls in a non-congested situation may be a concern (e.g., "why charge a toll when there is no congestion?"), a very high posted toll in a very congested condition may cause a form of sticker shock. Using a toll level to help manage congestion is complex concept and will need further review.

3. Use of net revenues (otherwise termed "excess revenues") – As demonstrated in the Task 3 working paper (a companion document), some corridors are forecast to generate more revenue than needed to cover their own capital, operations and maintenance, and centralized services costs. Other corridors do not generate enough net revenue to cover their costs. To have a regional HOT lane network be self-supporting, net revenues in some corridors will need to support costs for other less financially productive corridors. This issue will need further review.